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The Freshwater Planaria from South India

*With 3 Text-figures*

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**ABSTRACT** A new species of the genus *Dugesia* (Turbellaria, Tricladida, Paludicola), *Dugesia krishnaswamyi* Kawakatsu, sp. nov., from the Tamil Nadu district, South India, is described in the present paper. This new species is unique among the species of the genus in its large, extraordinarily well-developed valve surrounding the penis papilla with a moderately developed vagina.

On March 5, 1974, a number of middle-sized freshwater planarians were collected by the junior author, with a cooperation of Mr. Ar. Subbiah, from a small stream in the Alagercoil Hills (also spelled Alagercovil Hills and Alagar Koil Hills), about 20 kilometers southwest of Madurai, Tamil Nadu, in South India. After a brief examination of living specimens, they were preserved in Bouin's fluid in the spot. The material was sent to the senior author for identification with a sketch of the outline of the animal.

Upon examination of about 15 of the specimens under a binocular microscope, it was found out that 9 of them are sexually mature. Although the preserved condition of the animal is not good, a series of sections (stained with Delafield's haematoxylin and eosin; Kawakatsu's Specimen Lot No. 1256 group) can furnish a diagnostic description. The senior author has come to the conclusion that the present form is a hitherto undescribed new species of the genus *Dugesia*.

In the present paper, this new triclad turbellarian from South India is described by the senior author, together with some remarks about the ecology of the type-locality observed by the junior author. The authors take pleasure in naming this new species after Dr. S. Krishnaswamy, the Director and Professor of the Department of Biological Sciences, Madurai University, who is kind enough to allow the junior author (a laboratory technician) to do independent research.

## Order TRICLADIDA

## Suborder PALUDICOLA or PROBURSALIA

## Family Planariidae

Genus *Dugesia* GIRARD, 1850*Dugesia krishnaswamyi* Kawakatsu, spec. nov.

**Description.** This is a middle-sized to large, rather slender and dark pigmented epigeal species. General appearance of preserved, fully mature specimens is shown in photographs of Fig. 1 (A–D). The largest preserved specimen is 17 mm in body length and about 2 mm in width. The head is triangular in form, having a slightly pointed anterior end with blunt auricles. Behind the head, the body margins narrow slightly. Then, the elongated body gradually widens, reaching its greatest width at the middle part of the body. Behind a level of the mouth, the body narrows again to form a slightly pointed posterior end. Judging from the sketch drawn by the junior author of the body of the animal in life, the present new species has a typical head form of the Oriental *Dugesia* species (i.e., a rather broad, triangular head with well-developed but rather bluntly pointed auricles). The live specimens may attain about 25 mm or more in length.

All the specimens examined show a very dark coloration. The general color is uniformly blackish brown. There are numerous, very small, blackish pigments on the dorsal surface. The margin of the body and the areas above the pharynx and the copulatory organ are lighter brownish color. The ventral surface is brownish gray with numerous, small, dark brownish pigments. Two eyes are situated on the dorsal side of the head; the distance between them is somewhat wider than one-third the width of the head at the level of eyes. The auricular sensory organs of an elongated willow-leaf shape are visible on both sides of the head (Fig. 1A, B and D). Sensory spots are not conspicuous at the anterior margin of the body.

The pharynx is inserted at about the middle of the body and measures in length about one-sixth the body. The genital pore is situated in the midline at a very anterior level of the postpharyngeal region (the distance between the mouth and the genital pore amounts to about one-fifth the length of the postpharyngeal region) (Fig. 1C). A pair of spermiducal vesicles can be seen from the ventral side.

In large specimens the anterior intestinal trunk has 15 to 20 short lateral branches on each side; each posterior trunk has 20 to 30 or more short lateral branches. The histological structure of the pharynx is typical of the family Planariidae: the internal musculature of the pharynx consists of two distinct layers, a thick circular layer adjacent to the epithelium of the pharynx lumen and a thinner layer of longitudinal fibres. The external musculature of the pharynx consists of two layers, the outer longitudinal and the inner circular muscle fibres (Fig. 1E).

In the histological sections the dorsal epithelium is much thicker than the ventral and it is heavily provided with rhabdites. The marginal adhesive zone is developed.

A pair of rather small ovaries occurs in the usual ventral side between the third

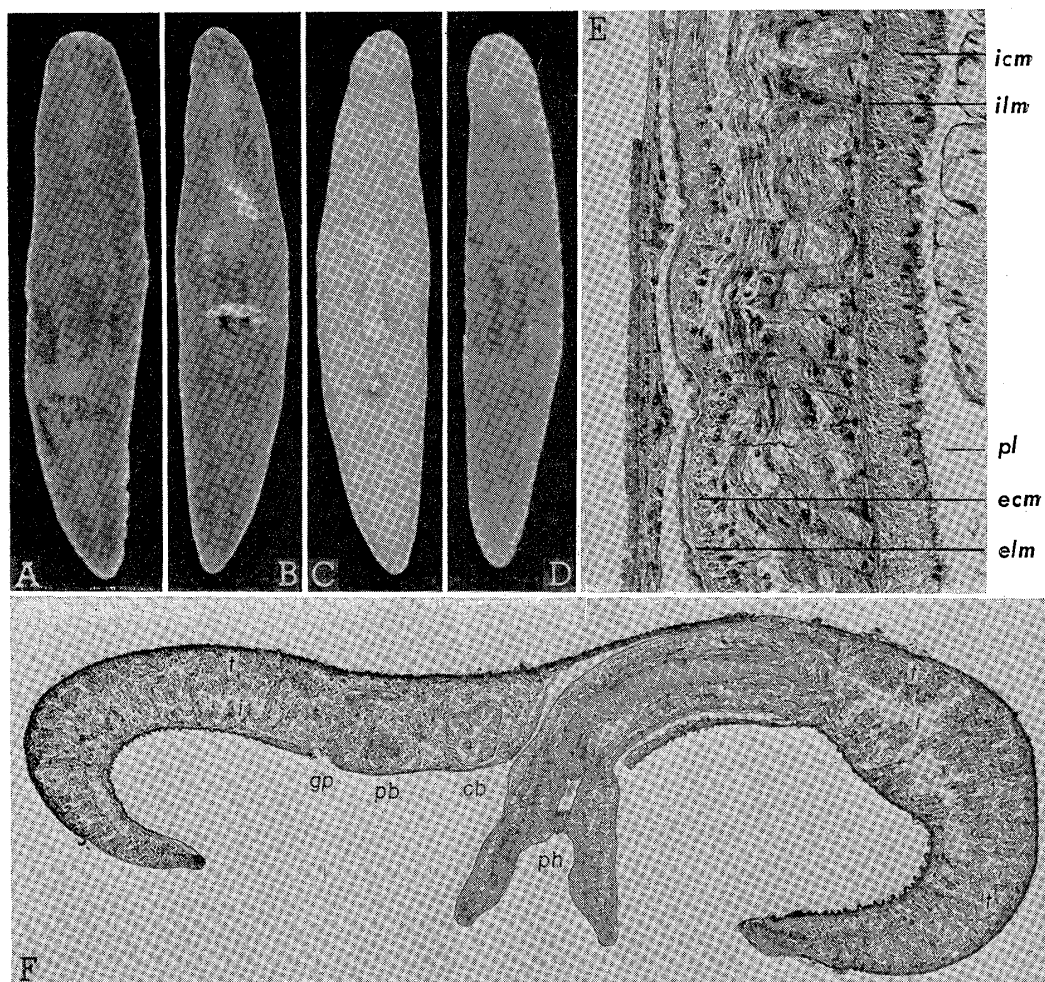


Fig. 1. *Dugesia krishnaswamyi* spec. nov. A-D: Three preserved sexually mature specimens (Specimen Lot No. 1256 group). C: Ventral view of the Specimen B. E: Photomicrograph of the sagittal section of the part of the pharynx (Specimen No. 1256 a). F: Photomicrograph of the mid-sagittal section showing the arrangement of testes (Specimen No. 1256 g).

cb, copulatory bursa; ecm, external circular muscle layer; elm, external longitudinal muscle layer; gp, genital pore; i, intestine; icm, internal circular muscle layer; ilm, internal longitudinal muscle layer; pb, penis bulb; ph, pharynx; pl, pharynx lumen; t, testis.

and the fourth intestinal diverticula. The two ovovitelline ducts converge in the region of the copulatory apparatus and open separately into the terminal part of the bursal canal (or the vagina) (Figs. 2A and B, 3A). Numerous yolk glands (or vitellaria) are distributed throughout the body in the surrounding parenchyma.

The testes are numerous, of small size, and are arranged on either side of the midline in three to four longitudinal zones extending from the posterior level of the ovaries to the nearly posterior end of the body (Fig. 1F). On examination of

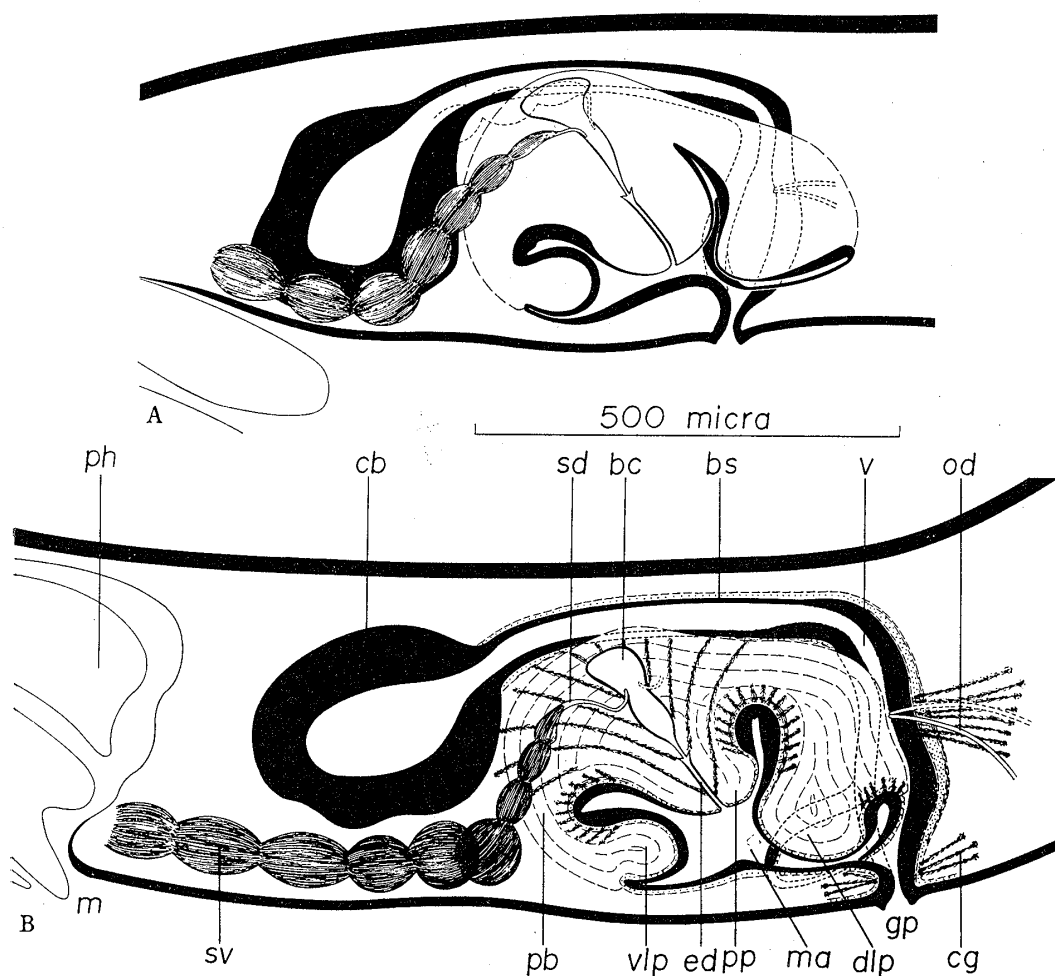


Fig. 2. Diagrams showing the sagittal view of the copulatory apparatus of *Dugesia krishnaswamyi* spec. nov. A: Specimen No. 1256 a. B: Specimen No. 1256 d (holotype). Same magnifications.

bc, bulbar cavity; bs, bursa stalk; cb, copulatory bursa; cg, cement gland; dlp, dorsal lip of the valve of the penis; ed, ejaculatory duct; gp, genital pore; ma, male antrum; od, ovovitelline duct; pb, penis bulb; ph, pharynx; pp, penis papilla; sd, sperm duct; sv, spermiducal vesicle; v, vagina; vlp, ventral lip of the valve of the penis.

the sagittal sections, their total number can be estimated at about 400 to 500. The spermiducal vesicles on either side of the posterior part of the pharynx and the copulatory bursa are highly conspicuous in the present new species (Figs. 2A and B, 3D). On the anterior side of the copulatory bursa, each spermiducal vesicles ascends vertically through the penis bulb, then narrows to a usual but very short, slender duct (sperm duct), and finally opens into the bulbar cavity separately at its middle part from both lateral sides (Figs. 2A and B, 3F).

The sagittal view of the copulatory apparatus of two specimens is shown in Fig. 2 (A and B). Photomicrographs of the parts of the copulatory apparatus of

four specimens are also shown in Fig. 3 (A–H).

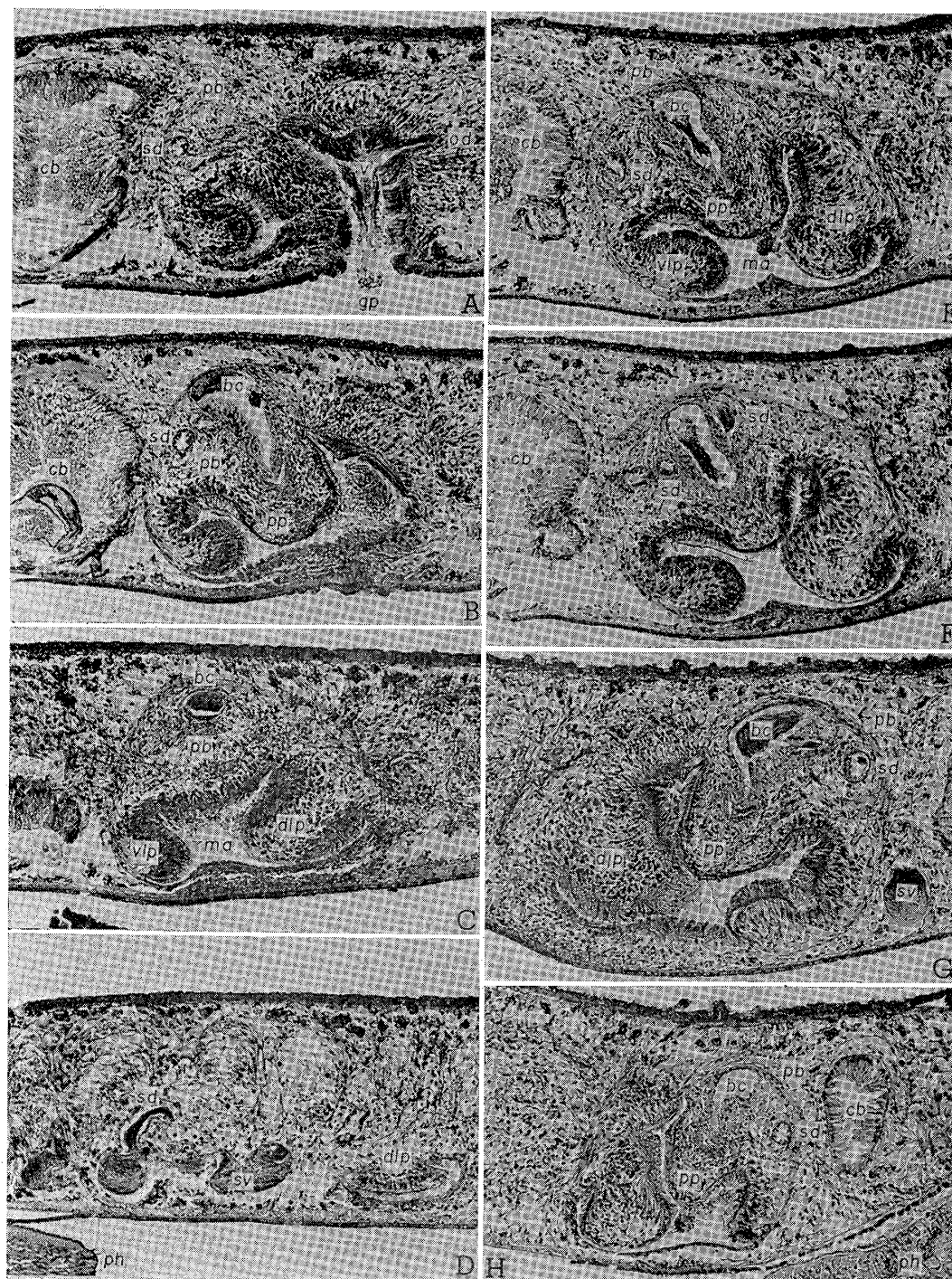
The penis has an extraordinarily large, hemispherical bulb embedded in the parenchyma and a moderately large, rather short, conical papilla of a slightly asymmetrical form projecting into the male genital antrum. Both the bulb and the papilla are highly muscular in nature. The bulb contains a moderately wide, elongated gourd-shaped cavity (bulbar cavity or seminal vesicle). It continues to the papilla as a narrow ejaculatory duct and opens at the ventral side of the penis papilla near its tip. A small diaphragm separates the bulbar cavity from the ejaculatory duct (Figs. 2A and B, 3B and G). The penis lumen (both bulbar cavity and ejaculatory duct) is lined with the usual glandular epithelium. The penis is pierced by numerous ducts of the penis glands which open into the penis lumen. The secretion of these ducts contains heavily eosinophilous granules.

As illustrated in Figs. 2 (A and B) and 3 (A–H), the dorsal lip of the penis papilla is slightly larger than the ventral one. The terminal part of the papilla is covered with a flat epithelium of a nucleate type. The valve or the diaphragm which forms a ring surrounding the base of the papilla is highly developed in the present new species. Usually, the dorsal lip of the valve is larger than the ventral one (and may attain mostly the same size of the papilla) (Figs. 2A and B, 3C, E and F). Both valves are muscular in nature. The epithelium that covers the terminal part of the dorsal lip of the valve is closely similar to that of the epithelium covering the terminal part of the papilla. The nucleate epithelium of the ventral lip and that of the basal parts of both lips and of the papilla are very thick, highly glandular and contain heavily eosinophilous granules. The cell bodies of these ducts are distributed at the region covered by a thick glandular epithelium.

The male genital antrum is a wide cavity with an irregular outline and opens to the genital pore postero-ventrally. The wall of the male antrum is closed with a tall, glandular, nucleate epithelium and is provided with two muscle layers, one circular and the other longitudinal. No common genital antrum is differentiated in the present new species.

The copulatory bursa is a middle-sized to large organ of an ovoidal shape (Figs. 2A and B, 3A, B, E, F and H). It is lined with a very tall, glandular epithelium. The bursa stalk, a rather wide and long duct, runs posteriorly close to the middle line and then curves ventrally. The anterior two-thirds of the bursa stalk has a muscular coat consisting of two layers of fibres, i.e., a thin layer of inner circular fibres and a thin layer of outer longitudinal. The posterior one-third of the bursa stalk forms a moderately developed vagina which opens into the genital pore (Figs. 2A and B, 3A). It accompanies a thick muscular coat: an inner thin longitudinal layer, a rather wide circular layer, and an outer thin longitudinal layer.

Fig. 3. Photomicrographs showing the parts of the copulatory apparatus of *Dugesia krishnaswamyi* spec. nov. A–D: A set of serial sagittal sections (Specimen No. 1256 a). A: Near mid-sagittal section. B: Mid-sagittal section. C and D: Near mid-sagittal sections. E and F: A set of serial mid-sagittal sections (Specimen No. 1256 b).



G: Mid-sagittal section (Specimen No. 1256 f). H: Mid-sagittal section (Specimen No. 1256 g).

bc, bulbar cavity; cb, copulatory bursa; dlp, dorsal lip of the valve of the penis; gp, genital pore; ma, male antrum; od, ovovitelline duct; pb, penis bulb; ph, pharynx; pp, penis papilla; sd, sperm duct; sv, spermiducal vesicle; v, vagina; vlp, ventral lip of the valve of the penis.



The glandular, nucleate epithelium of the bursal canal is much thicker at the region of the vagina than in other parts. The terminal part of the ovovitelline duct is accompanied by many eosinophilic glands. Weakly eosinophilous cement glands open into the female genital antrum near the genital pore.

The cocoon of the present new species is not known.

*Holotype.* One set of sagittal serial sections (Specimen No. 1256 d; four slides) will be deposited in the Department of Zoology, National Science Museum, Tokyo. One paratype will be deposited in the same Museum (No. 1256 g; two slides). The remaining paratypes including several whole mounts are retained by the senior author (Kawakatsu's laboratory, Fuji Women's College, Sapporo).

*Locality.* A small stream in the Alagercoil Hills, the vicinity of Madurai, Tamil Nadu, South India. Altitude, about 400 m. Collected by J. A. Basil and Mr. Ar. Subbiah on March 5, 1974.

*Taxonomic remarks and differential diagnosis.* Among the known Asiatic *Dugesia* species (cf. Ball, 1970; de Beauchamp, 1959, 1961; Ichikawa and Kawakatsu, 1964, 1967; Kawakatsu, 1965, 1967, 1969, 1972 a, b, c, d, 1973 a, b, and others; Kawakatsu and Basil, 1971), the following five species have an asymmetrical penis papilla with a diaphragm in the penis lumen and with the valve which forms a ring around the base of the penis papilla. They are: *Dugesia lindbergi* de Beauchamp, 1959, from Afghanistan, Pakistan and North India (cf. Kawakatsu, 1973 b; Kawakatsu and Ôgawara, 1974), *Dugesia batuensis* Ball, 1970, from Malaya (cf. Ball, 1970; Kawakatsu, 1972 a, c), *Dugesia hymanae* (Šivickis, 1928) from the Philippines (cf. Kawakatsu, 1972 d), *Dugesia indonesiana* Kawakatsu, 1973, from Sumatra and Java, and *Dugesia japonica* Ichikawa et Kawakatsu, 1964, from the Far East including the Japanese Islands (cf. Ichikawa and Kawakatsu, 1964, 1967; Kawakatsu, 1971; Kawakatsu, Horikoshi and Akama, 1972; Kawakatsu and Iwaki, 1967, 1968; Kawakatsu, Iwaki and Kim, 1967; Kawakatsu and Kim, 1966, 1967; Kawakatsu and Tanaka, 1971).

The present new species is easily separable from *Dugesia indica* Kawakatsu, 1969, in the details of the penial anatomy. *Dugesia* sp. (species of Madurai) Kawakatsu and Basil, 1971, is a small species and has the white stipples at the anterior margin of the body. The general color of the dorsal side is uniformly light brown with numerous dark brown pigments. Non-sexual, small specimens of the present new species have darker coloration than *Dugesia* sp. (species of Madurai). It is highly probable that they may be two different species.

*Dugesia krishnaswamyi*, the present new species, bears a striking resemblance in the anatomy of the reproductive system to *Dugesia batuensis*, *Dugesia hymanae* and *Dugesia indonesiana*. There is, however, an essential difference in the genital anatomy: in *D. batuensis* and *D. indonesiana* the penis has a highly asymmetrical form and the valve surrounding the basal part of the penis papilla is usually less-developed than that of the present new species. Despite a slightly asymmetrical penis papilla with a well-developed valve surrounding the basal part of the penis

papilla, the presence of the common genital antrum in *Dugesia hymanae* is one of the features that distinguish this species from the present new one. Moreover, *Dugesia krishnaswamyi* has a moderately developed vagina.

*Dugesia krishnaswamyi* differs from the other members of the genus in the following characters: living animal moderate to large in size and dark-colored with numerous, small pigment granules on the dorsal surface; head subtriangular with low blunt auricles; two eyes; external musculature of the pharynx consists of outer longitudinal and inner circular layers; numerous dorsal testes lie in three to four longitudinal rows on either side and extend to near the posterior end; penis bulb very large, hemispherical in shape and strongly muscular with an elongated gourd-shaped bulbar cavity into which sperm ducts enter separately; slightly asymmetrical penis papilla moderate and short conical form with a diaphragm in the ejaculatory duct; with extraordinarily developed valve at the basal part of the papilla; copulatory bursa moderate to large in size, with a bursal canal which opens into the female genital antrum; the posterior one-third of the bursa stalk forms a moderately developed vagina into which ovovitelline ducts enter separately.

*Ecological note.* The Alagercoil Hills is a tropical jungle located in the vicinity of Madurai in South India. The circumstance of the hills will be seen in photographs of our previous paper (cf. Kawakatsu and Basil, 1971, p. 50, pl. II). The type-locality of *Dugesia krishnaswamyi* is a small stream (alt., about 400 m). The source of the stream is a large permanent pool located at the top of the Alagercoil Hills (alt., about 1,500 m). In the type-locality the animals could not be obtained during the summer of 1974 because the stream was almost dried up.

The ecological and physico-chemical data of the Alagerkovil Wells, a pond fed by a spring water, which is a locality of *Dugesia* sp. (species of Madurai), are found in our previous article (*op. cit.*, pp. 44–46, table 1). The physico-chemical condition of the type-locality of *Dugesia krishnaswamyi* is very similar to that of the Alagerkovil Wells.

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